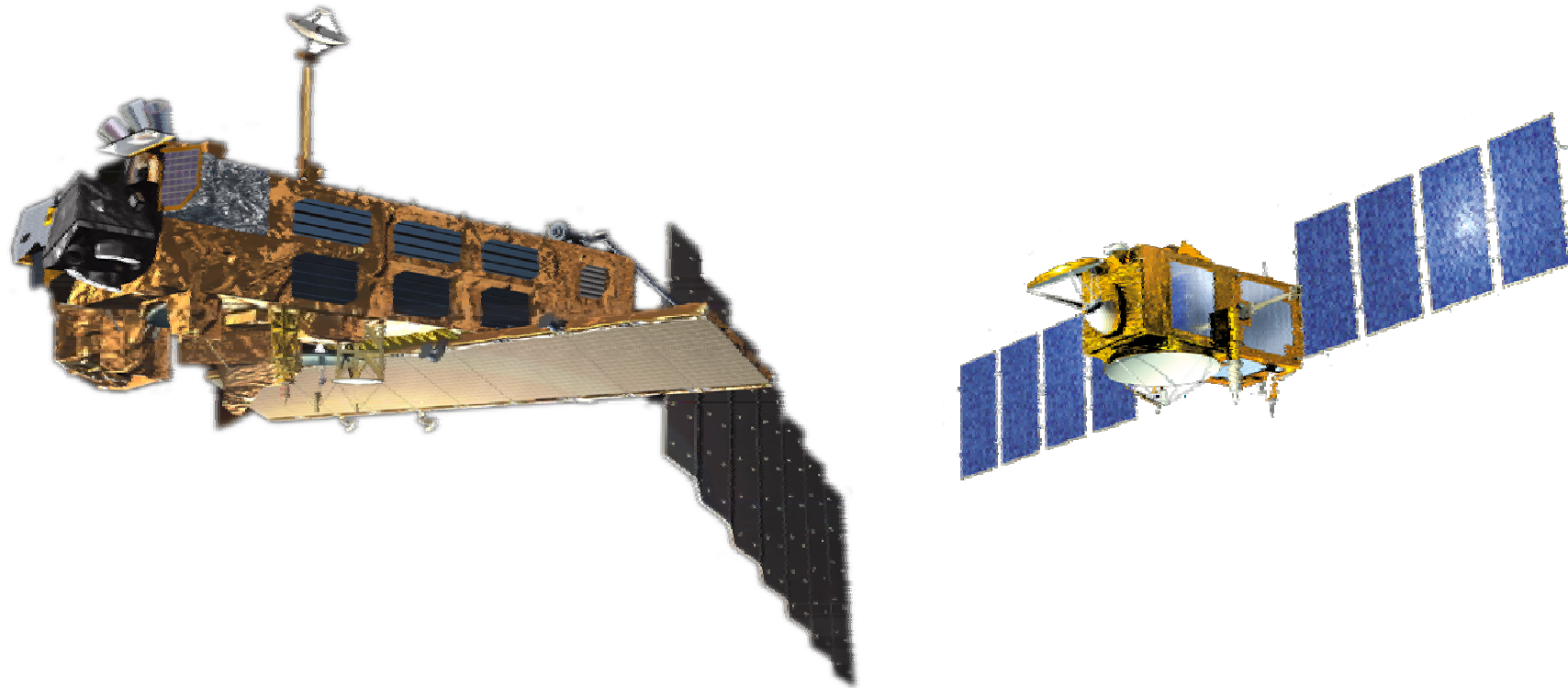


Envisat and Jason-1 dynamic orbit determination with DORIS data



Eelco Doornbos and Remko Scharroo
Delft Institute for Earth-Oriented Space Research
Delft University of Technology



Satellite characteristics:

	Jason-1	Envisat
Launch date	Dec 7, 2001	Mar 1, 2002
Orbit altitude	1336 km	800 km
Mass	481 kg	8078 kg
Approximate frontal area	13 m ²	100 m ²

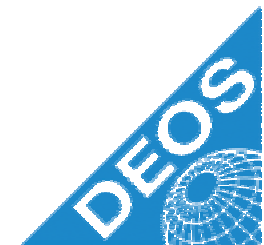
Tracking data and arcs

Jason-1 arcs:

- Ten 11-day arcs (02/01/15 – 02/04/25) with 1-day overlaps corresponding to cycles 1-10

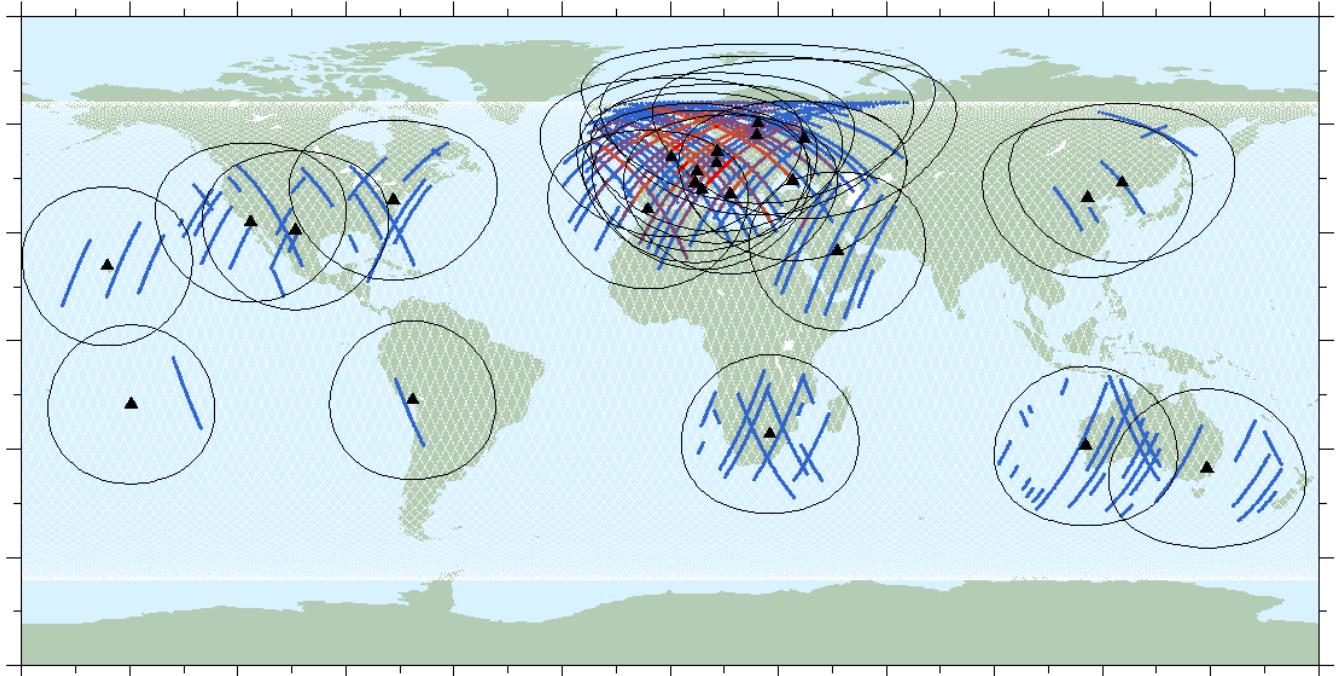
Envisat arcs:

- One 7-day arc (02/04/24 - 02/05/01)
- Two 4-day arcs with 1-day overlap



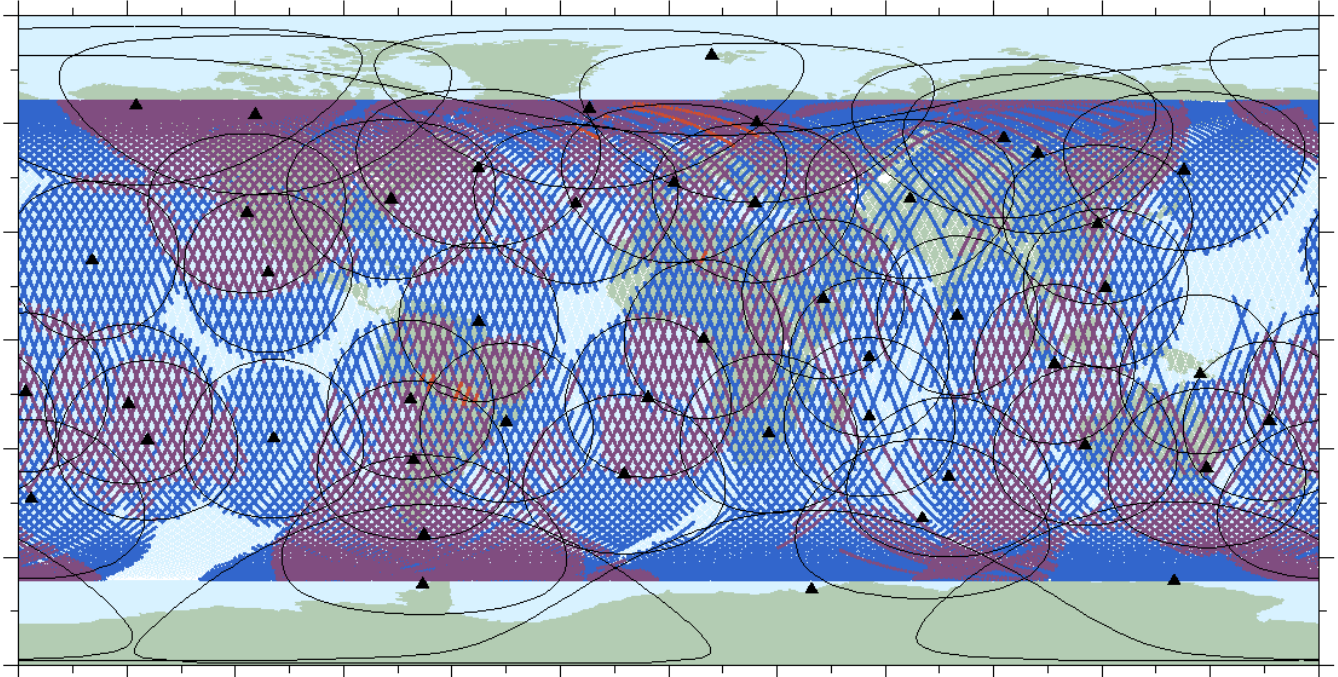
SLR

coverage: 6 %



DORIS

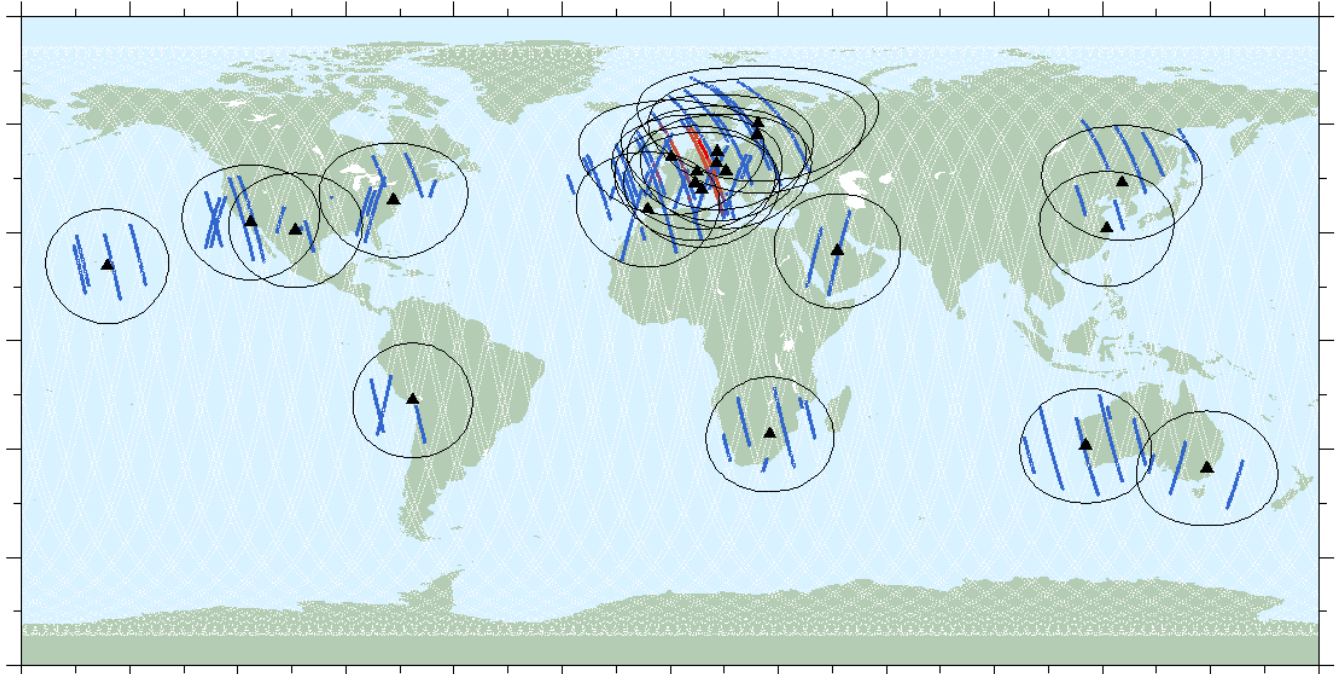
coverage: 88%



Jason-1
Cycle 010

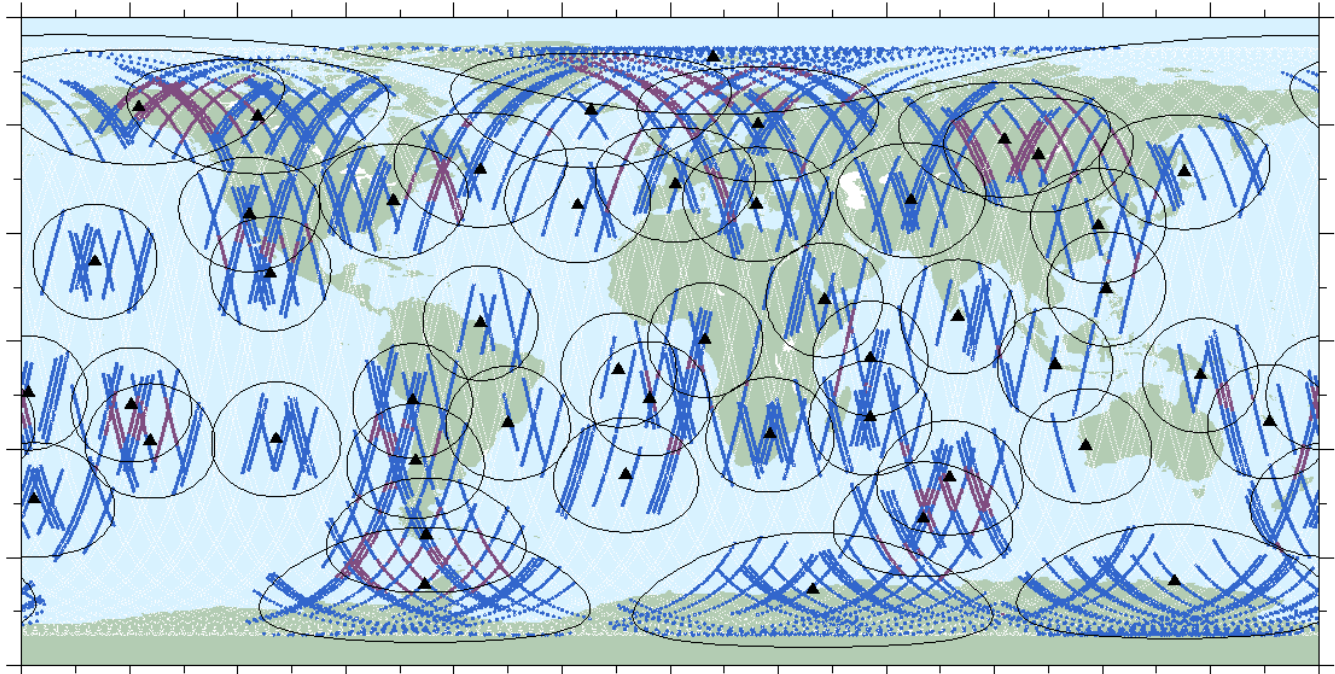
SLR

coverage: 3 %



DORIS

coverage: 31%



Envisat

2002/04/24 00:00

2002/05/01 00:00

Common models

Station positions:

- ITRF 2000 (SLR and DORIS)

Gravity field:

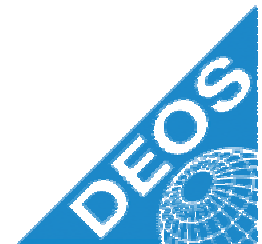
- TEG-4 (baseline)
- JGM-3, GRIM5-S1, EIGEN-1S, DGM-E04, DGM-E11 (comparisons)

Atmospheric density:

- MSIS-86 (baseline)
- DTM94, NRLMSISE-00 (comparisons)

Others:

- Sun, moon, planets, tides, etc.



Surface models

Envisat:

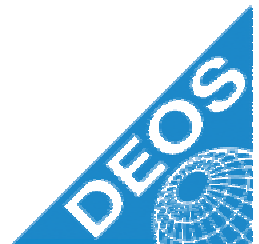
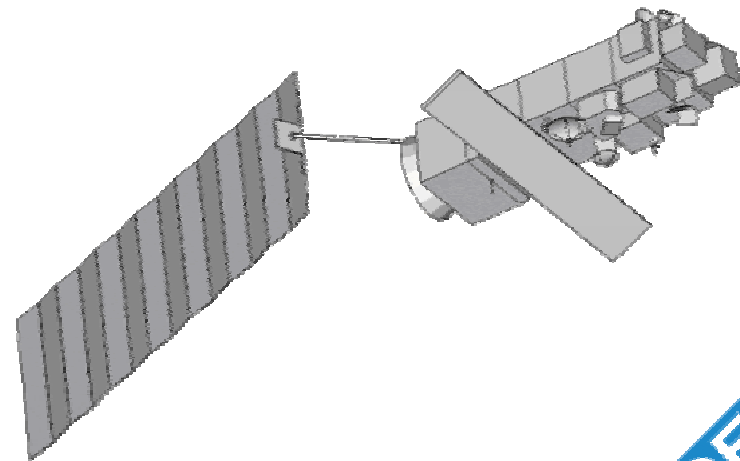
- ANGARA model (baseline)
- CNES box-wing panel model (comparison)

Jason-1:

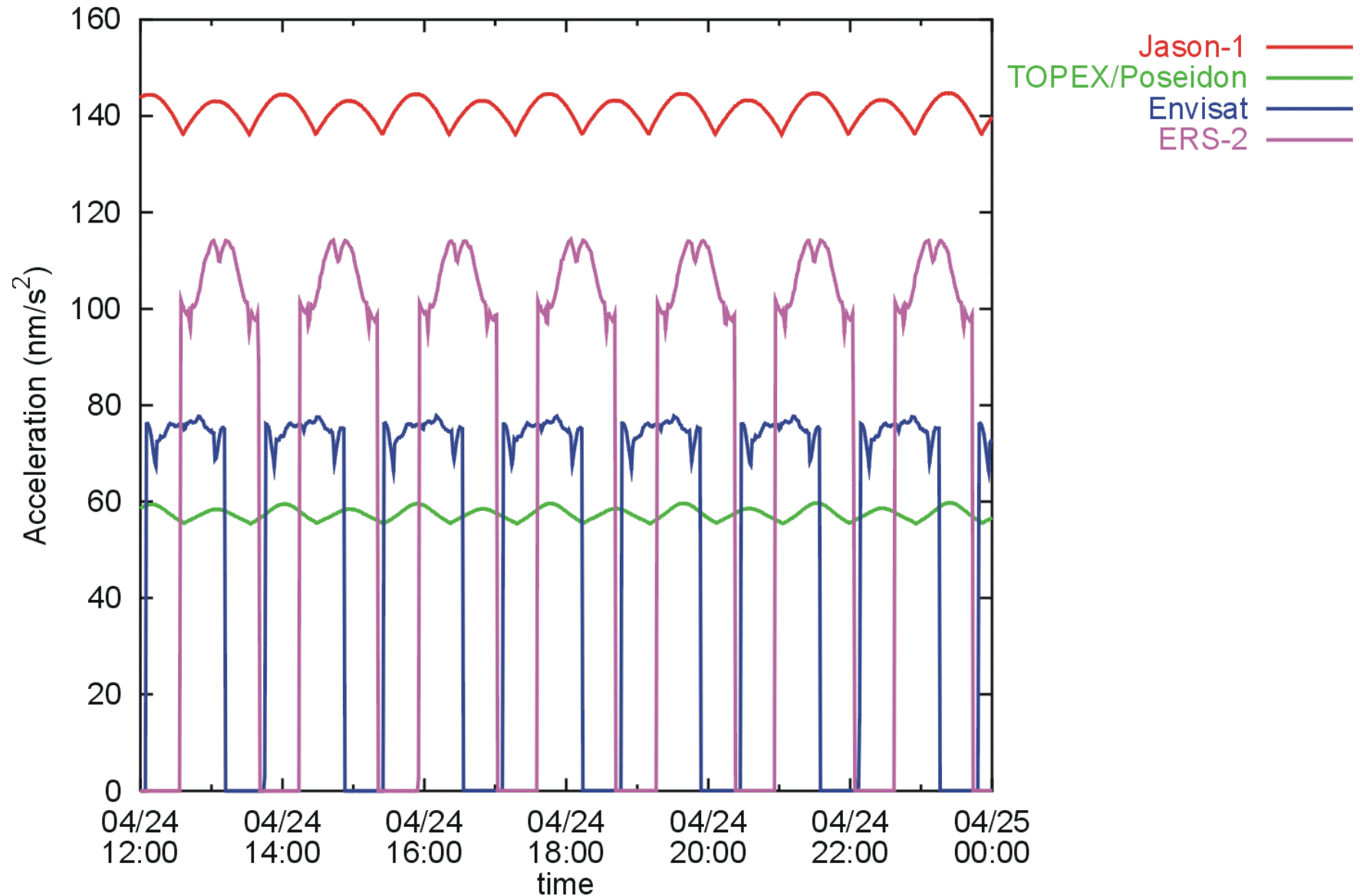
- CNES box-wing panel model

ANGARA model:

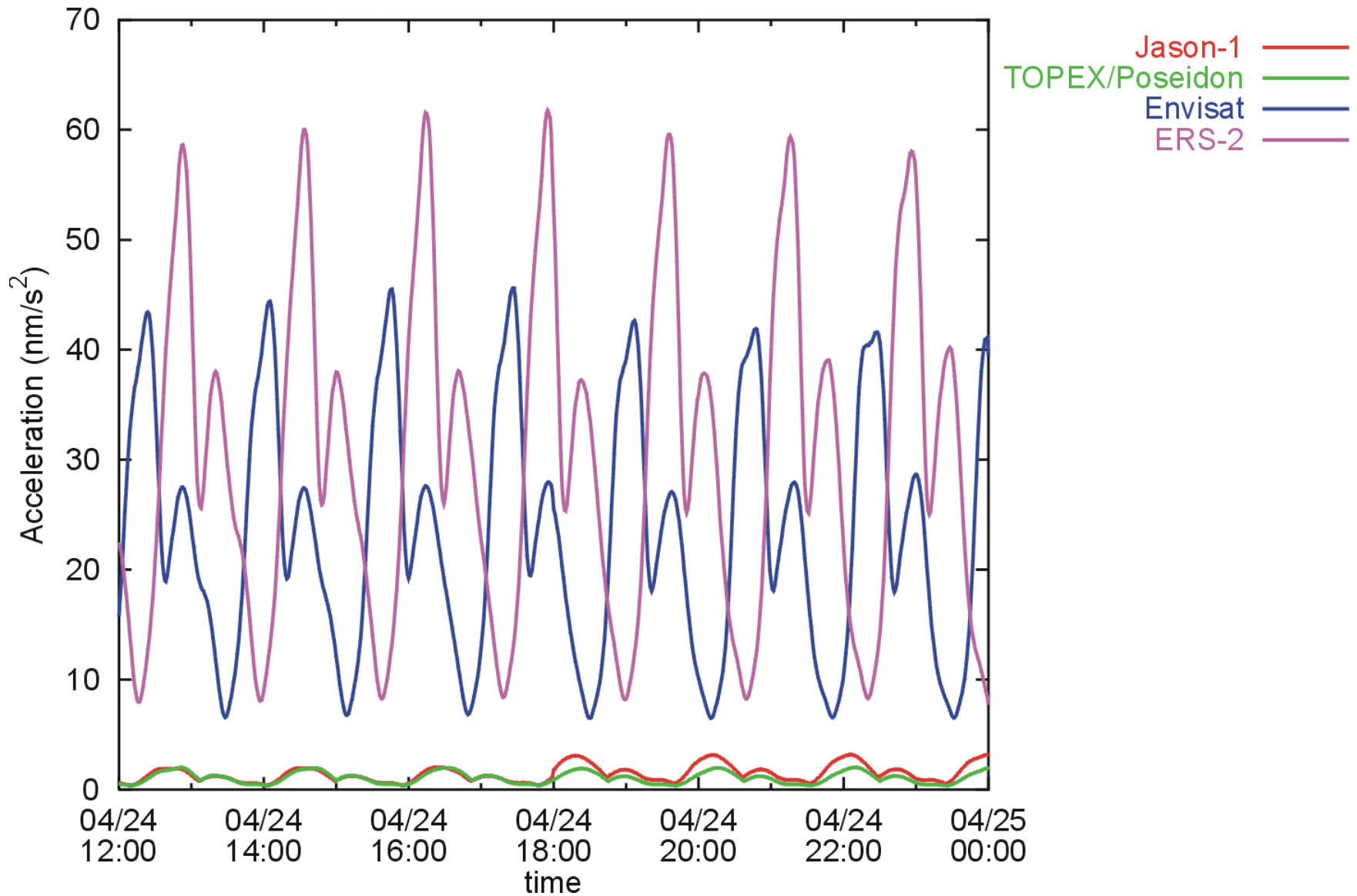
- Based on 'ray-tracing' using detailed geometry and physical models
- Interpolation from tables of normalized force vectors



Solar radiation pressure accelerations



Drag accelerations



Force model parameters

Empirical accelerations

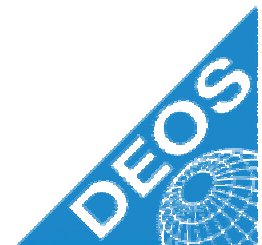
- Four parameters estimated per day: 1-cpr along-track and cross-track

Radiation pressure scale factor

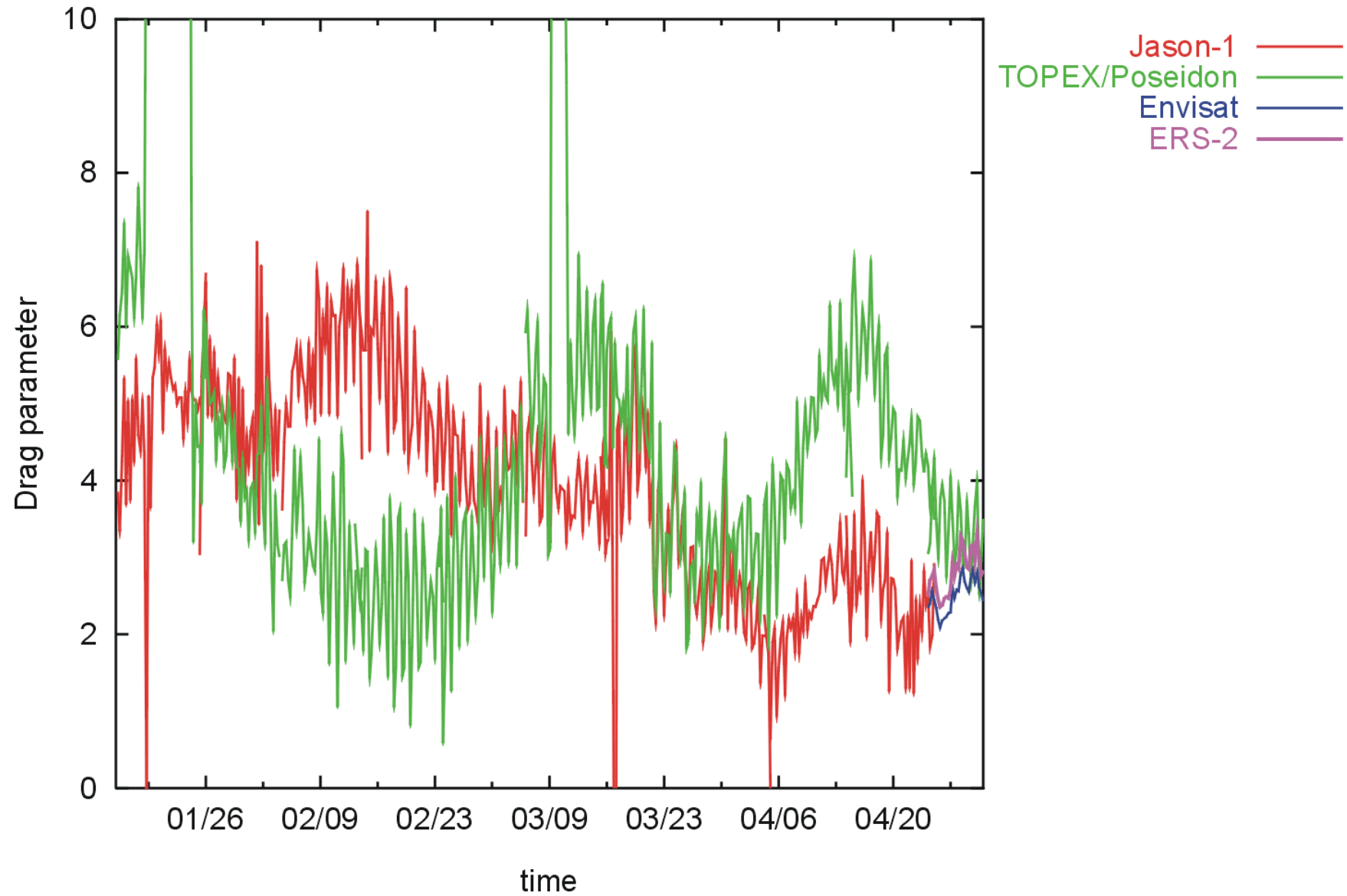
- Fixed value

Drag coefficients or scale factors

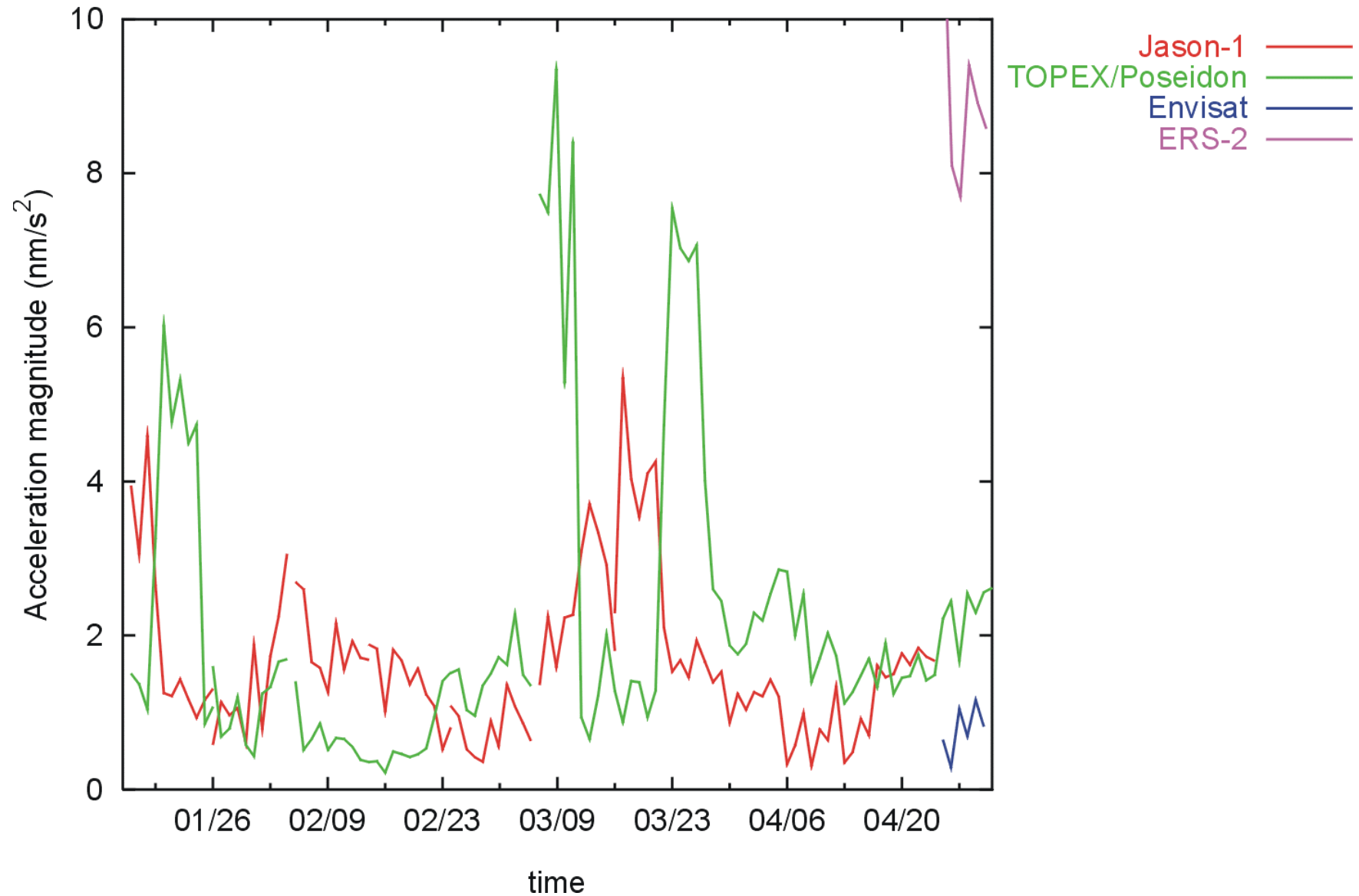
- Four parameters estimated per day (6-hourly)



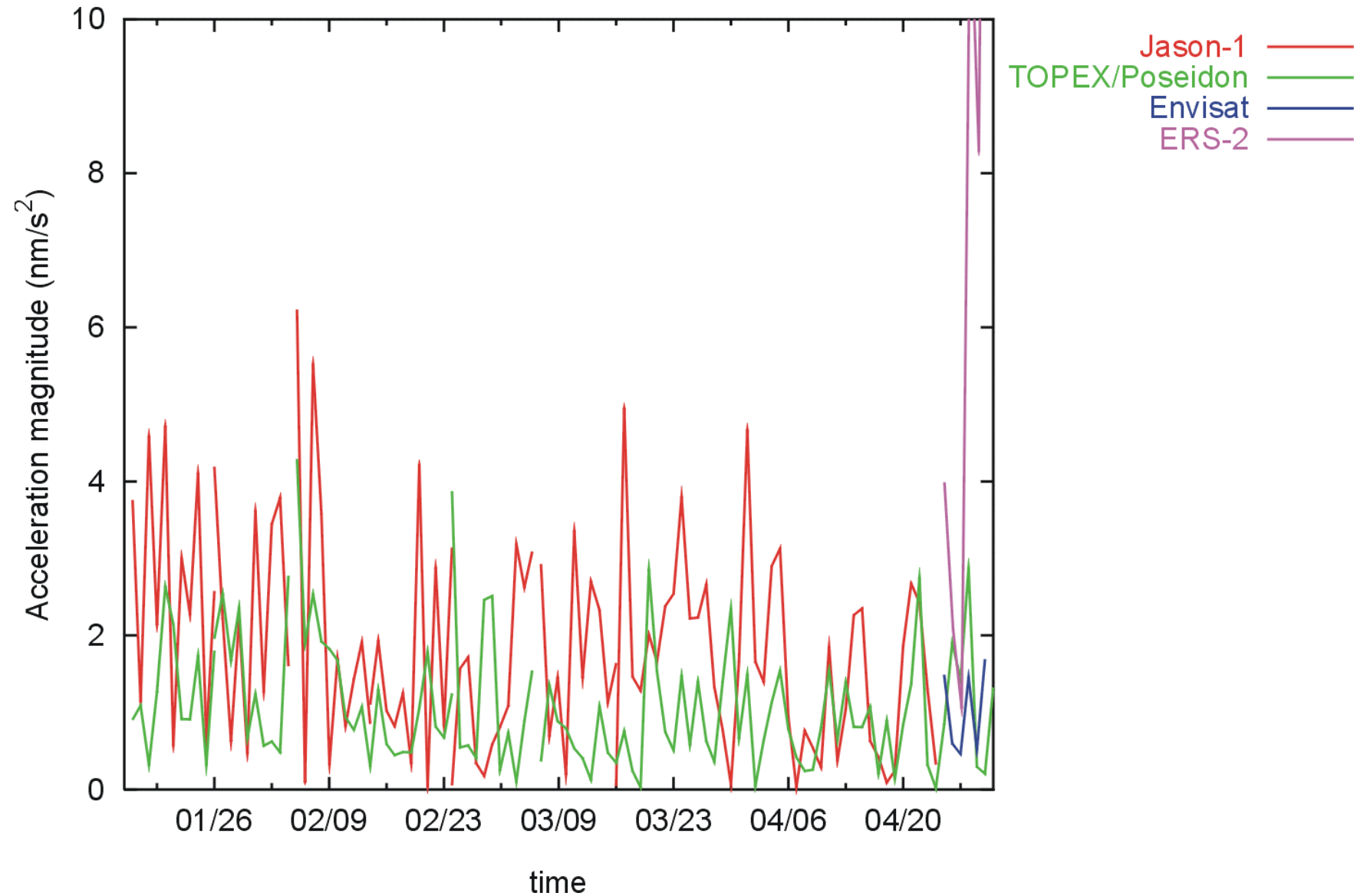
Estimated drag parameters



1-CPR along-track accelerations



1-CPR cross-track accelerations



Tracking residuals: Jason-1

Baseline models

Arc	#DORIS	RMS DORIS (mm/s)	#SLR	RMS SLR (cm)
1	105308	0.413	3171	2.5
2	96256	0.413	3172	3.8
3	106933	0.413	3339	2.8
4	115760	0.417	3425	2.3
5	108681	0.417	2599	2.4
6	103715	0.420	3393	2.7
7	111674	0.432	2966	3.6
8	118043	0.421	4615	2.8
9	115714	0.426	3532	2.6
10	112058	0.423	3533	3.5
Total	1094142	0.420	33745	2.86



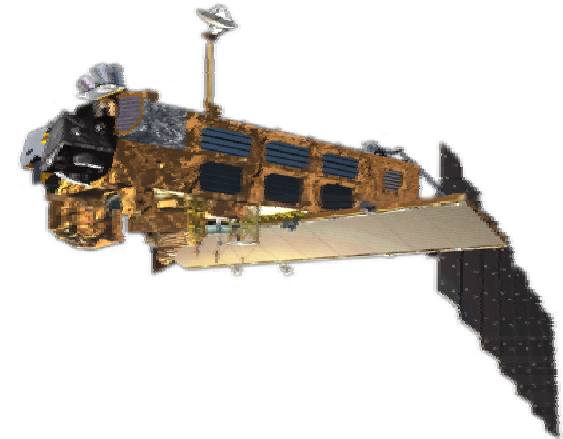
Gravity models

Model	DORIS	SLR
JGM-3	0.421	2.92
GRIM5-S1	0.422	2.89
EIGEN1S	0.422	2.89
TEG4*	0.420	2.86

Tracking residuals: Envisat

Baseline models

Arc	#DORIS	RMS DORIS (mm/s)	#SLR	RMS SLR (cm)
first 4 days	10422	0.508	620	4.7
last 4 days	14802	0.525	740	3.5
7-days*	21579	0.517	1179	4.2



Gravity models

Model	DORIS	SLR
JGM-3	0.539	5.2
DGM-E04	0.525	5.1
DGM-E11	0.517	4.6
GRIM5-S1	0.517	4.0
EIGEN1S	0.522	4.0
TEG4*	0.517	4.2

Surface force models

Model	DORIS	SLR
Box-wing panels	0.517	4.5
ANGARA*	0.517	4.2
MSIS-86*	0.517	4.2
NRLMSISE-00	0.518	4.3
DTM-94	0.525	4.5

Orbital arc overlaps

Jason-1

Arc	Along-track (cm)	Cross-track (cm)	Radial (cm)
1-2	12.55	1.90	3.12
3-4	3.40	2.31	1.01
4-5	1.78	5.10	0.55
6-7	6.89	3.17	2.95
7-8	3.29	8.63	1.12
8-9	5.41	5.69	1.36
9-10	4.45	2.90	1.32

Envisat

Arc	Along-track (cm)	Cross-track (cm)	Radial (cm)
1 st -2 nd half	6.07	4.28	1.19

Force model influence on orbit

Jason-1

Models	Along-track (cm)	Cross-track (cm)	Radial (cm)
TEG4-GRIM5	2.5	2.5	1.0
MSIS86 – DTM94	0.8	0.4	0.1

Envisat

Models	Along-track (cm)	Cross-track (cm)	Radial (cm)
TEG4 – GRIM5	6.7	4.9	1.8
ANGARA –Panels	4.2	6.0	1.6
MSIS86 - DTM94	9.3	1.5	1.3

External orbit comparison: Jason-1

CNES POE-DEOS

Arc	Along-track (cm)	Cross-track (cm)	Radial (cm)
1	6.19	5.45	2.14
2	9.31	5.91	2.66
3	6.46	8.52	1.70
4	6.21	5.38	2.14
5	6.46	6.02	2.19
6	6.75	7.72	2.14
7	11.11	7.47	3.16
8	6.62	6.47	1.98
9	7.00	6.21	2.28
10	6.30	6.21	2.25
Total	7.24	6.54	2.26

GSFC-DEOS

Along-track (cm)	Cross-track (cm)	Radial (cm)
5.68	3.30	1.66
9.55	3.45	2.05
5.63	4.84	1.52
6.46	4.29	1.67
6.11	3.74	1.65
5.83	4.74	1.59
5.67	3.96	1.62
5.30	4.07	1.74
6.5	6.05	1.97
6.30	4.27	1.72

External orbit comparison: Envisat

CNES-DEOS

Arc	Along-track (cm)	Cross-track (cm)	Radial (cm)
1 st part	28.60	8.74	3.33
2 nd part	15.98	7.74	2.75
7-day	24.37	8.29	3.11

Conclusions

Good quality Jason-1 orbits:

- It is easy to generate good quality orbits, due to dense DORIS tracking and available satellite model information
- Empirical accelerations indicate that some improvement might be possible for solar radiation force models

First Envisat results:

- Orbit quality seems similar to ERS-2
- ANGARA model seems to work well
- Orbit quality will benefit from improvements in gravity and surface force models
- DORIS tracking of Envisat may aid in improving these force models